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AN
INQUIRY
INTO THE
EFFECTS OF LIGHT
IN
RESPIRATION:

SUBMITTED, AS
AN INAUGURAL ESSAY,
TO THE
EXAMINATION
OF THE
REV. JOHN EWING, S. T. P. PROVOST;
THE
TRUSTEES & MEDICAL FACULTY,
OF THE
UNIVERSITY OF PENNSYLVANIA,
On the thirty-first of May 1800.
FOR THE DEGREE OF
DOCTOR OF MEDICINE.

—♦— 21385

BY JOSEPH TRENT, OF RICHMOND, VIRGINIA,

MEMBER OF THE PHILADELPHIA MEDICAL AND CHEMICAL SOCIETIES.

—♦—

“ Organization, sensation, spontaneous motion, and all the operations of life, only exist at the surface of the earth, and in places exposed to the influence of light. Without it nature itself would be lifeless and inanimate. By means of light, the benevolence of the Deity hath filled the surface of the earth with organization, sensation and intelligence.”

Elements of Chemistry, by M. Lavoisier.

PHILADELPHIA:

PRINTED BY WAY & GROFF,

No. 48, North Third-street.

1800.

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TO
JOSEPH GALLEG O, Esq.

OF
RICHMOND,
THIS DISSERTATION

IS INSCRIBED
AS A SMALL, BUT SINCERE, TRIBUTE

OF GRATITUDE AND ESTEEM,

BY HIS OBLIGED FRIEND,

AND HUMBLE SERVANT,

J. TRENT.

TO
COL. WILLIAM HETH,

COLLECTOR OF THE DISTRICT OF BERMUDA HUNDRED,
VIRGINIA;

AND TO
MR. JOHN RICHARD, JUN.

MERCHANT, PHILADELPHIA,

THIS INQUIRY

IS DEDICATED,

AS A MARK OF

RESPECT AND ESTEEM,

BY THE

AUTHOR.

THE

OF THE

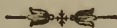
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be a member of his country's army, navy,
and air force.

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AN
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INTO THE
EFFECTS OF LIGHT, &c.



BY light I mean that subtile fluid, which is emitted from luminous bodies and is possessed of very singular and important properties.

Considered, as to its physical or chemical operation, light is certainly one of the most beneficial substances in nature. It not only conduces by its stimulus to organic existence, but as the medium of sight, it is the source of the most numerous and pleasurable of our perceptions; and upon its combinations depend some of the most beautiful and astonishing chemical phenomena.

No subject, therefore, can merit our attention more than the properties of this ethereal substance, by means of which all the beauty and glory of creation are laid open to our view.

It is the influence of light in respiration,* that I wish to establish in the following inquiry ; for which purpose I will deliver my observations and experiments under the three following heads.

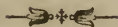
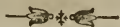
I. The colour of bodies depends upon combined light.

II. Light is a constituent element of oxygen gas.

III. The vermilion colour of blood depends, in part, upon the operation of light.

* I read a paper on this subject, before the Philadelphia Medical Society in February last, before I had ever seen or heard of the publication of Mr. Davy, in Beddoes' Medical Contributions.

SECTION I.

I. THE COLOUR OF BODIES DEPENDS
UPON COMBINED LIGHT.

PREVIOUS to the discoveries of the immortal Newton, our conceptions of the nature of light and colours were very imperfect, and to many of the ancients, this curious and important branch of philosophy, appeared to be involved in impenetrable darkness; for, in the opinion of Plato, to pry into the mysteries of light, was to encroach upon the prerogatives of Divinity.

Notwithstanding its obscurity, many conjectures were advanced on this subject by some of the older opticians.

The celebrated Des Cartes argued very rationally that colour was a modification of light; and after him many others thought the differences of colour depended upon the condensation and rarefaction of this subtile ethereal substance.

Their speculations, however, though sometimes ingenious and plausible, were unsupported by experiment or any kind of evidence; and it was not till the time of Sir Isaac Newton, that our ideas of light were by any means just or accurate.

By a multitude of the clearest and most decisive experiments, this great man has satisfactorily unfolded many of the most important properties of light, and has left behind him a theory of light and colours, by the assistance of which, we are enabled to account for many phenomena, which were before inexplicable.

His doctrine of the materiality of light and of the different colours depending upon the different refrangibility of the rays of light, though founded on experiment, and supported by the most ingenious reasoning, was strenuously opposed by cotemporary and succeeding philosophers, especially by the celebrated Euler, who supposed light to consist in vibrations propagated from luminous bodies through a subtile etherial medium.

This hypothesis, though advocated with great zeal by M. Euler, is completely refuted by the friends of the Newtonian doctrine, especially by Messrs. Michell and Melville, whose experiments and observations establish most decidedly that light is a substance and not a quality.

It would not comport with the usual limits of an inaugural essay, to enter further into a disquisition of this kind; I must therefore refer the reader to the several books on optics.

I believe it is generally agreed among philosophers, that the diversity of colours, and variety of shades, under which bodies present themselves to our view, depend upon the operation of light. Many experiments have been made, and much ingenious reasoning advanced in support of this opinion.

Duhamel* demonstrated long ago, that the colour and inward texture of some bodies are changed in consequence of their being exposed to light.

He found that the juice of a certain shell fish contracted a fine purple colour, when it was exposed to the light of the sun, and that the stronger the light, the more splendid was the colour. Pieces of cloth dipped in this juice, and exposed to the sun, became red, though they were inclosed in glass; but they suffered no change, if in the same exposure they were covered by any thing that intercepted light.

After this, Beccarius† applied himself with diligence and success, to the investigation of this curious subject, and found by many experiments, that the colour of various substances was altered by exposure to light, exclusive of heat or any other circumstance.

* Priestley on vision. Vol. II. p. 373.

† Ibid. Vol. II. p. 379.

That neither heat nor air contributed to the production of those changes, was proved by repeating the same experiments in a much higher temperature in a darkened room, and by exposing the substances in an exhausted receiver; for under these circumstances, the absence or presence of light, was observed to have very great influence on the results of the experiments. In the first, no change took place, whereas in the exhausted receiver the substances underwent the same change when exposed to light as before.

I shall relate, in the course of this inquiry, some experiments on blood, which corroborate those of Duhamel and Beccarius, and I hope they will demonstrate clearly and decidedly the colouring power of light.

The influence of light on organized beings is very remarkable. Animals deprived of it and living in dark places, lose their colour and become white, as is observable in Arctic animals during the long nights, in the countries near the pole.

“ Worms and grubs, Mr. Dorthes observes, which live in the earth or in wood, are of a whitish colour. The birds and flying insects of the night, are likewise distinguishable from those of the day, by the want of brilliancy of colour; and the difference

is equally marked between those of the north and of the south."

Animals which inhabit tropical climates, where the light is constant and intense, possess much deeper and more brilliant colours, than such as live to the north. Wild animals by domestication, always lose their dull and obscure colours, and become much brighter, and more beautiful, in consequence of a more frequent exposure to the light of the sun; and it is remarked, that the colour of our domestic animals during winter, is less bright, than in summer. Doctor Girtanner has observed, that animals which conceal themselves for the the greatest part of the year, in subterraneous dwellings, lose their colour and become white; and that mice kept in a cage, in a dark room, have produced white mice.

The influence of light on vegetation, is still more remarkable; for, by depriving plants of it, they not only lose their delicate shades, but sicken and die, and when in green-houses, the light is admitted to them from a particular part, they incline towards it, as if to shew how *essential* this fluid is, to their existence.

The importance of this substance, and its power of producing colour in plants, have been noticed by several authors. "Without the influence of light, says Chaptal, vegetables would exhibit but

one lifeless colour; they are deprived of their beautiful shades by the interception of this luminous fluid.”* Agreeable to this writer, and M. Fourcroy,† vegetables are not only indebted to light, for their colour, but likewise for their smell, taste, combustibility, maturity and the resinous principle: And hence, that aromatic substances, resins, volatile oils, and those colouring matters, of so much value for their liveliness and body, are peculiar to southern climates, where the light is more pure, constant and intense.

The immortal Lavoisier entertained the same opinion of the importance of this fluid with respect to vegetative existence and its power of imparting colour to vegetables. “Experiments upon vegetation,” he observes, give reason to believe, that light combines with certain parts of vegetables; and that the green of their leaves, and the various colours of their flowers, are chiefly owing to this combination. This much is certain, that plants which grow in darkness, are perfectly white, languid and unhealthy, and that to make them recover vigour and to acquire their natural colours, the direct influence of light is absolutely necessary.”‡

* Elements of Chemistry.

† Elements of Natural History and of Chemistry.

‡ Elements of Chemistry.

Mr. Davy, § has proved by experiment, that the colour of vegetables depends upon light, and that by depriving them of this fluid, they become white, though naturally of a deep colour. He found, that red rose trees, when included from light, before their flowers began to appear, produced flowers almost white; and that flowers naturally white, if exposed to a concentrated light, became highly coloured.

Fruits are also indebted to light, for their beautiful colours, and I have often observed, that that part of them, which is most exposed to the sun, is always of the deepest colour.

Deprived of light, vegetables not only lose their delicate shades, but also their noxious properties. Some poisonous plants, by the abstraction of light, lose their deleterious qualities, and become agreeable to the taste, and even harmless when taken into the stomach. It is in this way, that gardeners prepare many vegetables for our tables. The celery, endive and other esculent vegetables, by this treatment, lose their green colour and active qualities, and become white and wholesome articles of diet.

In common with the inferior order of beings, man himself is indebted to light for his colour, as well as the most numerous of his pleasures.

In tropical climates, where the light is stronger and more constant, the inhabitants are observed to be of a deeper colour, than those who live to the north, under a much less powerful sun. In Africa, the natives are black, while in the northern parts of Europe they are white, and between these two quarters of the globe, are to be found all the intermediate gradations of colour.

Our own seasons afford us a striking example of the colouring power of light. During the scorching heat of summer, when the light is very intense, our skins often become highly coloured or tanned, as we commonly express it; whereas in winter, when the sun is not so powerful, we lose the colour acquired in summer, and become much fairer.

It is invariably found that such parts of our bodies as are exposed to light are coloured, while those that are covered by our clothes, remain perfectly white. Ladies, who are less exposed to the sun, are fairer than men; and men in confinement soon lose their florid complexions, if they are deprived of light.

I have observed that many of those gentlemen, who go to the East-Indies, though fair when they leave this country, acquire very brown complexions before they return; which circumstance, can only be ascribed to the greater concentration and reflec-

tion of the light of the sun from the water, in that warm climate.

In what manner colour is produced by the operation of light, I shall not pretend to explain; it is a subject still involved in very great obscurity. Whether it is by abstracting oxygen or any other principle from the body, is not ascertained with sufficient certainty to warrant a conclusion.

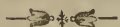
The colour of the skin depends upon the colour of the rete mucosum; which in the African is black, in the European white, while it is of an intermediate or copper colour in the American. Doctor Beddoes imagined that the black skin of the African, was produced by the abstraction of oxygen from the rete mucosum by light, and his experiments seem to favour this hypothesis; for by exposing the fingers of a negro in the oxigenated muriatic acid, which easily parts with its superabundant oxygen, they soon became white. Doctor Girtanner asserts, that white animals and plants are more irritable, than those that are coloured; and irritability he proves to depend upon oxygen. By the abstraction of light they lose their colour, and become much more irritable in consequence of an accumulation of this principle.

This theory of the operation of light, explains with ease and perspicuity, the diversity of colour

observed in different countries. The stronger the light and more constant its application, the greater will be the abstraction of oxygen, and the deeper the colour produced. It is in this way, that the various colours of organized beings are accounted for; but the production of colour in inorganic substances, is not to be explained with the same ease by this hypothesis, for great changes take place in some substances exposed to light, in which the presence of oxygen has never been detected.

Besides the loss of colour, which would inevitably follow the privation of light, our atmosphere would be rendered uninhabitable, from the supply of pure air being cut off; in the production of which the operation of light is absolutely necessary.

SECTION II.

II. LIGHT IS A CONSTITUENT ELEMENT
OF OXYGEN GAS.

ACCORDING to M. Lavoisier and other celebrated chemical philosophers, pure air consists of oxygen combined with caloric or the matter of heat. This doctrine has obtained very generally among chemists, and from it is drawn the present theory of respiration and combustion.

However easily explicable the phenomena of those processes may appear to be, by this theory of oxygen gas, I shall attempt to prove that light is one of its principles; and that it is partly to the action of this ethereal substance, that some of the phenomena of respiration ought to be attributed.

That light enters into the composition of oxygen gas, I infer, from its analysis and synthesis. It is well known, that in every rapid decomposition of pure air, light is liberated, and all our experiments to form acids and metallic oxyds, prove it to be one of the elements of pure air. By the combustion of carbone, hydrogene, and other simple

substances in oxygen gas, a large quantity of the most brilliant light is liberated; to account for which, we must either admit that it is a principle of this gas, which is disengaged by its decomposition, or adopt the opinion of Macquer, who supposed that the light was emitted from the burning body.

This celebrated chemist attempted to unite the pneumatic theory with that of phlogiston, and by a doctrine drawn from the two, he certainly explained the phenomena of combustion with great ease and perspicuity; but unfortunately for his theory, no experiments were adduced in support of it.

The light emitted by the sun, Macquer regards as the matter of fire, and that by admitting it as fixed in bodies, it constitutes the phlogiston of Stahl. According to his theory, in every combustion, the oxygen gas disengages the light or phlogiston from inflammable bodies, and occupies its place.

It is a sufficient refutation of this theory, that no phenomena prove or require its existence; whereas, that of light being disengaged from oxygen gas, not only solves the phenomena, but is directly drawn from a multitude of experiments.

We have no evidence of the existence of light in carbone, hydrogene or iron; yet by the com-

bustion of these substances in pure air, to form carbonic acid, water and the calx of iron, a great quantity of vivid light is liberated.

The following experiment, made by Mr. Davy, establishes, in the most positive and unequivocal manner, that light is contained in oxygen gas.

“ A small gun lock, armed with an excellent flint, was snapped in a vessel filled with oxygen gas. The particles of steel, separated by collision, were the most brilliant that can be imagined; and these particles, examined by a magnifier, were found to be converted into black oxyd of iron. The same experiment was made in a vessel filled with carbonic acid gas; the iron was fused, but no light was liberated.”*

This experiment not only proves that light enters into the composition of pure air, but establishes its existence independent of caloric. From light and heat being generally concomitant, many philosophers† have supposed, that they are cause and effect; but the above experiment, in conjunction with another, made in an exhausted receiver, in

* Beddoes' Medical Contributions.

† “ We are unable to determine, whether light be a modification of caloric, or caloric be, on the contrary, a modification of light.”

Lavoisier's Elements of Chemistry.

which no light appeared, yet the metal was fused, proves that light is not a modification of heat ; and goes a great way, in my opinion, to establish the non-existence of caloric, or the matter of heat.

From many experiments made by Mr. Davy, and those of Count Rumford,* on friction, I am disposed to doubt the materiality of heat. An opinion, however, the reverse of this is advocated by some of the first philosophers in Europe.

The most powerful arguments have been adduced on both sides of the question ; but it appears to me that the force of reasoning and certainly the weight of experiment, are against the existence of caloric.

This controversy between men of such distinguished talents, affords a true, though melancholy proof of the imbecility of the human mind and of the imperfect state of science. When such men as Black, Crawford, Lavoisier and Rumford dispute, who can decide ? It would be presumption in me to advance an opinion.

The materiality of heat is certainly questionable ; and when probability is shaken, reason strongly inclines to scepticism.

* *Essays Political, Œconomical and Philosophical.* Vol. II.

Though I entertain doubts on this subject, I by no means deny, that heat is matter, and that it acts a very important part in the œconomy of the universe; on the contrary, I shall consider it, as one of the elements of pure air.

By the experiments of M. Berthollet, light appears to have great affinity with oxygen, and contributes with caloric to change it into the state of gas.

This theory of the constitution of pure air, quadrates best with most of our experiments, and by it, the phenomena of combustion and respiration admit of a more easy and satisfactory explanation.

The existence of light in pure air, is also demonstrated by synthetical experiments. The attraction of light for oxygen is so powerful, that few bodies which contain the latter principle in a loose state of combination, can hold it when exposed to light.

It is proved by the experiments of Doctors Priestley, Ingenhouz and Mr. Davy, that vegetables, when exposed to solar light, decompose water and carbonic acid. The hydrogen of the water and carbone of the acid, are attracted by the vegetable, while oxygen is disengaged in the form of gas, by combining with light.

It is by virtue of these affinities, that the pure air of our atmosphere is continually renewed. Man and other animals, live only by the assistance of the vital air which they breathe; whereas vegetables imbibe and are nourished by the air which animals vitiate in their respiration, and in return discharge torrents of vital air.

Thus we see by what simple and æconomical means, the numerous beings on the globe are supported. The two great classes of organized bodies depend for their existence on the labours of each other, and they are both dependant on light.

This is not the only way by which we prove the recomposition of oxygen gas. Many inorganic substances, which contain oxygen, give it out, when in contact with light. A bottle of oxigenated muriatic acid exposed to the sun, parts with its superabundant oxygen; but if in the same exposure, the bottle is covered with any thing that will intercept light, the acid suffers no change; and when heated in a dark place, Chaptal observes, is even reducible into gas without decomposition. The nitric acid also, when exposed to the sun, affords oxygen gas; whereas heat alone volatilizes it, without decomposition.

The muriate of silver and red oxyd of mercury,

part with their oxygen in the form of oxygen gas, when exposed to the light of the sun.

M. Lavoisier observes, when speaking of the reduction of red precipitate in a porcelain retort, "As the oxygen gas never appears till the retort becomes red, it seems to prove the principle established by M. Berthollet, that an obscure heat can never form oxygen gas, and that light is one of its constituent elements."

What a wonderful coincidence of facts, to prove that light is a component part of pure air!

The very author, who makes pure air to be a combination of oxygen and caloric, has in his definition of combustion, acknowledged light to be one of the principles of this air.

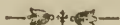
According to Lavoisier, "Combustion is the decomposition of oxygen gas, produced by a combustible body. The oxygen which forms the base of this gas, is absorbed by, and enters into combination with, the burning body, while heat and light are disengaged."

It will be unnecessary for me to multiply instances of the composition and decomposition of oxygen gas, to prove that light is one of its constituent elements.

SECTION III.



III. THE VERMILLION COLOUR OF BLOOD DEPENDS, IN
PART, UPON THE OPERATION OF LIGHT.



HAVING demonstrated, I hope, in the preceding parts of this inquiry, that light is a constituent principle of oxygen gas, and that most colours depend upon combined light; I will go on to prove by experiment, the operation of this subtile fluid on blood, especially in contributing to produce its florid colour; from which circumstance, and from the action of light on other bodies, I shall infer its influence in respiration.

According to the most popular theory of respiration, vital air is decomposed in the lungs; the oxygen by combining with the blood occasions its vermilion colour, while the caloric is set at liberty and produces animal heat.

If, agreeable to this doctrine, oxygen gas is decomposed in the lungs, light must be liberated, as well as caloric, as we have made it appear that light is a component part of this gas. It is therefore, more especially our object, in this place, to

establish by experiments on blood and by deductions from analogy, the effects of this principle in respiration. Light from its extreme tenuity, is capable of passing unaltered through the pores of diaphanous bodies; I procured, therefore, very transparent phials to experiment with, and when I wished to ascertain the effects of light alone, every precaution was used to prevent the co-operation of other agents.

EXPERIMENT I.

A vein of the arm was opened, and two phials, holding each two ounces, were filled with blood. Great pains were taken to prevent the contact of air, by applying the phials as near to the vein as possible, and by corking them as soon as they were filled. One of these phials was immediately exposed to the sun, which was shining very bright. The other was put away in a dark closet. After remaining in this situation for two hours, they were examined, and the following appearances were exhibited. The blood in the phial exposed to solar light, had lost its dark venous colour and was turned red, but the colour was not half as bright as when in contact with atmospheric air. That part of the blood which was shaded, in some degree, by resting against the window, was not as bright as that which looked directly to the sun, though it was altered considerably in colour.

The phial in the dark closet suffered no change.

As the blood was placed in the sun, I entertained doubts, whether or not heat might have contributed to the change. To ascertain this point, therefore, the following experiment was made.

EXPERIMENT 2.

A vein being opened, the stream of blood was directed into a two ounce phial, which was held as close to the arm as possible, to avoid the contact of air. In this way three phials were filled and after being well corked, they were disposed of in the following manner:

One was placed in the sun, shining very bright, about 11 o'clock, A. M. another, after being covered with black, was likewise exposed to the sun: but the third was put away in the dark closet.

In two hours they were examined. The blood in the first phial was turned red, as in the preceding experiment; in the second, which was exposed as the first, but covered with black, the blood suffered no perceptible change; which was also the case with the third.

This experiment satisfied me that light and not heat, was the agent which produced the change,

for upon examining the two phials placed in the sun, I found that the one covered with black was considerably warmer than the other, yet no alteration took place in the colour of the blood it contained; whereas the blood in the other, which was not so much heated, and from which light had not been excluded, soon acquired a red colour.

I can ascribe, therefore, the want of colour in the second phial, to nothing else but the interception of light by its black covering.

Though this experiment removed my doubts as to the cause of the change, yet as my friend and fellow-graduate, Mr. Robert Berkeley, who witnessed the making of these experiments, still believed in the co-operation of heat, I made the two following experiments, which prove most decidedly, the influence of light exclusive of heat, in colouring of blood.

EXPERIMENT 3.

Two phials, holding each two ounces, were filled with venous blood, and after being well corked, one of them was immersed in snow on the outside of a window, on which the sun shone very bright. About one third of the phial from top to bottom, was exposed to solar light, by scraping off a part of

the snow; while the rest of it, was completely immersed and excluded from light.

The other phial was placed as usual, in the closet.

Upon inspection two hours after, I found that part of the blood on which the light had fallen, was turned red, while the part opposite to this and secluded from light, though altered in colour, was not near as bright as that which looked immediately to the sun.

The blood in the closet suffered no alteration.

Here the co-operation of heat could not be suspected, for it is well known, that all bodies in passing from the solid to the fluid state, as was the case with the snow, absorb heat; therefore, the blood in this experiment, instead of acquiring, must have lost its own heat, very soon after immersion.

EXPERIMENT 4.

A vein of the arm was opened, and two phials were filled with blood from it, the usual precautions being observed.

One covered with black, was placed before a fire, the warmth of which was as much as I could endure. The other was exposed to the sun, which shone with great splendour.

The blood before the fire was examined frequently for two hours and better, but no change in colour was observed to take place; whereas, that exposed to the light of the sun became altered in a very short time, and at the expiration of two hours, it was as red as in the preceding experiments.

The influence of light, exclusive of heat or air, in colouring of blood, is unequivocally demonstrated by these experiments, which have been repeated with precisely the same results.

The blood turned red by light, if exposed in darkness soon lost its colour and became very black, and was not to be coloured again by re-exposure to light, however intense.

I also remarked, that the blood which had remained in the dark closet for three or four hours, was with difficulty robbed of its black colour, and never contracted so bright a red as fresh blood, though the most concentrated light was applied.

What this could have been owing to, I know not; but think it probable, that during its cooling, the blood may have parted with some principle, or undergone some peculiar change, which indisposed it to receive a red colour, from the action of light alone. We know that from blood just drawn a

considerable halitus arises, and after becoming cold, I have found its colour with difficulty changed, even by oxygen gas.

To ascertain what would be the effect of exposing blood in the same atmosphere, but to different degrees of light, I made the following experiment.

EXPERIMENT 5.

Two small china bowls were nearly filled with venous blood and the room was darkened by bringing too the window shutters. Through an aperture in the shutters, a small quantity of very brilliant solar light was admitted, which fell upon and completely covered the surface of the blood in one of the bowls. The other bowl was placed by the side of this, but no light from the aperture was allowed to fall upon it.

In this situation they continued for two hours, when upon examining them, it was found, that the blood on which the light had fallen, was turned of a most brilliant vermilion colour; while that in the bowl which was exposed in the same atmosphere, but to a weaker light, had acquired a colour much less florid.

This experiment unequivocally demonstrates the power of light in augmenting the vermilion colour

of blood, and taken in conjunction with the other experiments and observations contained in this inquiry, goes a great way, in my opinion, to establish the influence of this ætherial substance in respiration. Let us apply those facts to explain some of the phenomena of this important function.

Respiration is considered, by physiologists, as an operation, by means of which oxygen gas is continually passing from the gaseous to the concrete state; it must therefore at each instant abandon the caloric (and light too) which held it in solution and in the state of gas.

According to this theory, oxygen gas is decomposed in the lungs; its base combines with, and gives a florid colour to the blood, while its caloric is set at liberty and produces animal heat. I believe in the decomposition of pure air in respiration, but cannot agree that all the phenomena of this function are produced by oxygen and caloric; nor will the reader find any difficulty in admitting of the co-operation of light, if he will compare the preceding observations and experiments, with this doctrine, which is universally received. Combustion and respiration are said to be two complex chemical processes, whose phenomena are the same or very similar. Now the liberation of light is admitted in combustion, by the advocates of the present theory, yet

they say nothing of its disengagement in respiration. If oxygen gas is decomposed in these two processes, certainly the principles of this gas must be liberated in both. In combustion, which is a more rapid decomposition of pure air, the disengagement of light is very evident to our senses; whereas in respiration it is impossible to have any such evidence, not only in consequence of the concealed situation of this process, but of the slower and more gradual decomposition of pure air in the lungs.

We can therefore judge only of the liberation and effects of light in respiration, by the nature of the air expired and by experiments on blood out of the body.

By the researches of the illustrious Priestley and Lavoisier, the composition of our atmosphere and the nature of the airs expired, have been fully developed. The air we respire is found to consist of azotic and pure air, in the proportion of 72 parts of the former to 28 of the latter, which undergoes very remarkable changes in the lungs.

Doctor Goodwin found, by experiments on himself, that the diminution of pure air and the increase of fixed air,* was considerable, in a single respiration; while the azotic air suffered neither increase nor diminution. Now if agreeable to the doctrine

* The air he breathed contained 2 parts in 100 of fixed air.

of Goodwin and Girtanner, the increase of fixed air, is owing to the oxygen of the decomposed pure air, uniting with the carbone of the blood, it must of necessity follow that light is liberated, for we have proved by experiment,* that light does not enter into the composition of carbonic acid; nor have we any evidence of its being contained in azotic gas or in water, which is the other product of respiration.

A late ingenious writer, Mr. Davy, denies the decomposition of vital air in respiration, and asserts that the liberated carbonic acid and water are constituent principles of venous blood, which are displaced by the vital air; for which the venous blood has a greater elective attraction, than for its constituent elements, water and carbonic acid.

Mr. Davy denies the existence of caloric altogether, and makes oxygen gas to consist of light and oxygen, to which he has given the name of phos-oxygen.

As the reader may not have seen this gentleman's paper, I will give a short view of his theory.

“Respiration, he observes, is a chemical process, the combination of phos-oxygen, with the venous blood in the lungs, and the liberation of carbonic acid and aqueous gas from it. From the combina-

* Vid. p. 21.

tion and decomposition arises an increase of repulsive motion, which, combined with that produced by the other chemical processes taking place in the system, and that generated by the reciprocal action of the solids and fluids, is the cause of animal heat ; a heat which the other systems have supposed to arise chiefly from the decomposition of oxygen gas, oxygen and caloric.”*

Mr. Davy supposes, that the florid colour of blood is produced by phos oxygen combining with it, in its entire state, and urges the following objections to the decomposition of pure air in respiration.

Carbone, hydrogen and iron, he says, never decompose oxygen gas at so low a temperature as 98° and that it is never decomposed by those substances, without combustion, flame and great heat.

This is assuming more, I apprehend, than daily observation and experience authorize, for we know that the combinations of oxygen are decomposed by many substances in a temperature much lower than that of the human body. Several of the metals are calcined by exposing them in a moist atmosphere, without any perceptible liberation of light or heat. In fermentation and putrefaction, large quantities of carbonic acid are formed and extricated in a temperature much inferior to that of the lungs and without combustion or flame. His objections, there-

* Beddoes' Medical Contributions.

fore, to the decomposition of oxygen gas, in respiration are not founded. But admitting for a moment, that oxygen gas cannot be decomposed in follow a heat as 98° , in our laboratories, are we from thence to infer, that the lungs have not the power of decomposing it? Do not vegetables decompose water and carbonic acid, with the utmost facility, in the ordinary temperature of our atmosphere? Have we any experiments that prove the principles of water and carbonic acid to be in a weaker state of combination, than those of oxygen gas? Since then vegetables can decompose some of the strongest combinations of oxygen, why deny a similar faculty to a more perfect order of organized beings? Is it wise in us to estimate the powers of the animal œconomy, by those of an imperfect art? Certainly not; for the more we investigate the structure and operations of animated beings, the more are we struck with the faculties they possess, and convinced of the wisdom of their Creator!

I have no doubt of the decomposition of oxygen gas in respiration, but cannot ascribe all the phenomena of this important function to the exclusive action of oxygen and caloric, as most chemical philosophers have done.

I conclude, therefore, and think my conclusion is warranted by the preceding observations and experiments, that light is a constituent element of oxygen

gas, and that it is to the disengagement* and operation of this substance in respiration, that some of its phenomena ought, in part, to be attributed, more especially the vermillion colour of pulmonary blood.

There is no knowing what discoveries may be made in this important subject, by a more extensive chemistry. By the researches of Priestley, Lavoisier and other celebrated chemists, many of the elements are already known to us, and it is to be hoped that by a continuance of their labours, the nature of those subtile fluids will be discovered, which at present elude the perception of our senses and are only known to us by their direful effects.

* May not the electroid fluid be produced in this way? Is electricity any thing more than "light in a condensed state?"

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